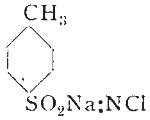
chlorine is linked to nitrogen, has strong germicidal properties. It has the following structure:



and was first prepared in 1905 by Dr. Chattaway, who, however, did not discover its antiseptic action. It is most conveniently obtained by adding sodium hypochlorite to toluene sulphonamide. It is a colourless, crystalline substance, which in the solid form is quite stable, and when dissolved in water can be kept unchanged for many months. It is without corrosive action, is non-toxic, and does not coagulate protein. Its germicidal action is, molecule for molecule, about four times that of sodium hypochlorite. It is, however, less irritating than the latter, and can be used at a concentration five to ten times as great.

A report from Staff-Surgeon A. R. Fisher on the use of chloroamine in the treatment of wounds of the mouth and jaw appeared in the *British Medical Journal* for January 15, and the cases described, though few in number, are reported as "distinctly encouraging." Finally, mention may be made of the use of electrolysed sea-water for the disinfection of hospital ships. The large number of sick and wounded recently brought home from the Near East in hospital ships made the question of disinfection imperative. Though the production of hypochlorite by the electrolysis of salt solution for bleaching purposes, and the powerful antiseptic properties of hypochlorite so produced, have long been known, the idea of electrolysing sea-water on the vessel which is to be disinfected is a novel one, and due to Dr. Dakin, who has successfully solved the problem of disinfection in this simple, cheap, and effective way. The apparatus consists of an electrolytic cell, which, with a current of 65–75 amperes and 110 volts, yields a solution of 2 parts per 1000 of hypochlorite in five minutes at a cost of about 3*d*. per 100 gallons. This solution, diluted with an equal volume of sea-water, is sufficiently strong to sterilise floors, decks, latrines, etc. It has been used on the *Aquitania* on her last two voyages, with excellent results.

NOTES.

SINCE we went to press last week the report of the Committee on Retrenchment, which led the Government to decide on the closing of museums, has been published. We have not space here to analyse its arguments, but this is the less necessary since they were speedily countered in a letter to the *Times* of February 4 by "A Biological F.R.S." This seems to have closed the newspaper discussion, and we are now waiting to see the effect of to-day's deputation to the Prime Minister, organised by the Museums Association. Among the speakers will be Lord Sudeley, Sir Ray Lankester, and the director of the National Museum of Wales. The petition to be presented has been signed by leading men in all parts of the country. The provincial museums recognise that the action of the Government is intended as an example for them to follow, and they fear that they may be subjected to pressure through the Local Government Board. They will not, however, submit without a protest, and that protest will be made on purely patriotic grounds, for the municipal and other museum authorities know very well the admirable educational work that is being carried on among all classes of the population by their institutions. It is not only in London that our soldiers are deriving pleasure and profit from the museums; at Colchester, for example, the presence of soldiers in training has raised the annual attendance from 29,564 to 339,933, to which latter figure must be added some 18,000 for Sunday afternoons in the winter months. Meanwhile, it is stated by the *Neue Freie Presse* that in Germany and Austria all libraries, museums, and picture-galleries are open as usual, and the reasons given for closing them in this country are regarded as "a declaration of moral bankruptcy," more striking than the economic weakness which so fatal and futile a decision is held to reveal.

AT the annual general meeting of the Society of Public Analysts, held on February 2, Mr. G. Embrey was elected president for the ensuing year.

THE Royal Swedish Academy of Science in Stockholm has elected Prof. E. B. Poulton a foreign member as a token of its appreciation of Prof. Poulton's work in zoology, and especially in entomology.

THE work of completing the laboratory building and first range of plant houses at the Brooklyn Botanic Garden is now proceeding. We learn from *Science* that the completion of these buildings at this time has been made possible by the donation, by three friends of the garden, of 20,000*l*. on the condition that a like sum be appropriated for the same purpose by the city of New York.

AT the meeting of the Chemical Society held on February 3 the second of the series of lectures arranged by the council to be delivered during the present session was given by Prof. W. H. Bragg, who chose as his subject, "The Recent Work on X-Rays and Crystals, and its bearing on Chemistry." Dr. Alexander Scott, president, was in the chair, and the meeting was largely attended. After the delivery of the lecture, a discussion was held, in which Prof. H. E. Armstrong, Mr. William Barlow, Lieut. Bragg, and Sir William Tilden took part.

THE death of Prof. John Wyllie, emeritus professor of medicine in the University of Edinburgh, occurred on January 25 at the age of seventy-two years. Prof. Wyllie held various appointments in Edinburgh hospitals from 1868 to 1900, when he succeeded Sir Thomas Grainger Stewart as professor of medicine in the University, and occupied the position until 1914. His chief published work on the disorders of speech was published in 1894. He was also the author of a number of papers in medical journals.

MR. C. W. BEEBE, curator of birds to the New York Zoological Society, has sailed for British Guiana, where he intends to establish a tropical zoological station for observation and research. His primary object will not be the collection of specimens—though he hopes to send home a steady stream of living creatures with special attention to the rarer types—but the intensive study of birds and animals in their own haunts. He proposes to build a bungalow at the edge of the jungle, and to equip it with a complete laboratory outfit. The Government of British Guiana has offered Mr. Beebe the use of its botanical gardens and of wild Government land. His associates in this expedition will be Mr. I. Hartley, Mr. P. Holmes (whose interest is in photography and work with insects), and Mr. Carter, a collector.

THE shortage of synthetic dyes in this country and the United States has naturally greatly increased the demand for certain vegetable dyestuffs, which have in their turn risen in price, and in some cases are proving very difficult to obtain. In particular there has recently been a serious scarcity of logwood in this country. In the past the chief British sources of supply of this wood have been Jamaica and British Honduras, but some years ago the Imperial Institute investigated the possibility of exporting logwood from another British Colony—Mauritius. A trial shipment of this logwood was found to be of excellent quality, and in 1912 an offer to take a considerable quantity of the wood was obtained from a leading British dye firm. At that time, however, the price offered for the wood was not high enough to encourage the export, but, in view of the higher value at present ruling, the Imperial Institute has now succeeded in arranging for a considerable supply of Mauritius logwood to be utilised in this country.

A BRITISH Industries Fair is to be held by the Board of Trade in the ground floor courts of the Victoria and Albert Museum on February 21–March 3. The cooperation of the Board of Education, in permitting the use of the museum for the present practical object, is, says the *Times*, a healthy evidence of the desire of the Government to give to British industries and manufacturers some of that official assistance and encouragement by which the commerce of other countries, of Germany especially, has been so largely built up. For the forthcoming fair at South Kensington the Board of Trade has already sent out some 20,000 invitations to probable buyers in foreign countries, and invitations will in due course also be sent to about 80,000 persons in the British Isles, the names having been largely compiled from lists of customers which the manufacturers themselves have put at the disposal of the commercial department of the Board. The manufactures included in the exhibition will be: (1) toys and games; (2) china and earthenware; (3) glass; (4) fancy goods; and (5) printing and stationery.

DR. J. G. BOWMAN, of Chicago, director of the American College of Surgeons, is reported by *Science* to have stated recently that the college has obtained from its fellows an endowment fund of 100,000*l.*, to be held in perpetuity, the income of which only is to be used in advancing the purposes of the college. The college has been in the process of formation for the last three years. It has a temporary office in Chicago, and it is probable that permanent headquarters will be decided upon within a few days. The president is Prof. J. M. T. Finney, head of the surgical clinic of Johns Hopkins Hospital, Baltimore. The college is modelled after the Royal College of Surgeons of England, and has the support, it is said, of nearly all the leading surgeons in the United States and Canada. The college, which is not a teaching institution, but rather a society or a college in the original sense, now numbers about 3400 fellows in Canada and in the United States.

DR. RODOLPHE ENGEL, whose death was announced in NATURE of January 27, was born at Fegersheim, in Alsace, in 1850. His father, who was professor of botany in the faculty of medicine at Strassburg, was transferred after the Franco-German war to the new University of Nancy, where his son, after serving his time in the army, completed his studies, and was the first doctor of medicine of the new faculty. Shortly after he graduated doctor of science at the Sorbonne, and became successively professor of chemistry in the faculty of medicine at Montpellier and at the Ecole Centrale des Arts et Manufactures, where his teaching powers were greatly appreciated. Prof. Engel devoted himself to both pure and applied chemistry. Thus he investigated creatine, taurine, the synthesis of aspartic acid, the allotropic form of arsenic, and many crystallised hydrochlorides of metallic chlorides. It was to Engel's ingenuity that the process of transforming potassium chloride into carbonate in the cold by the intermediate formation of a double salt of magnesium is due, a process which was exploited by Germany and used at Strassburg for many years. Prof. Engel was also engaged in the commercial production of plastic substances such as viscose.

MR. E. HERON-ALLEN has been elected president of the Royal Microscopical Society for the ensuing year. In his presidential address, delivered on January 19, he referred to the extensive field now covered by work in microscopy. The microscope is now an indispensable adjunct, not only to every branch of science, but also to most trades. But though its applications have thus been widely dispersed, its essential and peculiar scientific principles remain as a field of specialised scientific inquiry, and this becomes more apparent every day in these times of profounder and ever-widening research. At the present time the society has an excellent opportunity of increasing its influence on the development of microscopic technique and appliances, and the programme for the new session should attract to the meetings many fellows of the society, as well as other scientific workers. Next week Messrs. Rousselet, Earland, and Heron-Allen will give an exhibition, and a joint paper "On the Progress and Development of Vision and Definition under the Microscope." In March Prof. J. Arthur Thomson will deliver an address on "Original Factors in Evolution"; and in April Prof Benjamin Moore, one on "Early Steps in the Evolution of Life." Later, Mr. J. E. Barnard will deal with the progress and results of some of his studies in branches of microscopic research. A paper is expected from Prof. S. J. Hickson, and one by Mrs. Helen P. Goodrich, upon the history of, and the recent work done upon, the mysterious dental disease known as pyorrhœa. At all the meetings a special feature will be made of the technical methods to be employed with the view of showing the obtained results in the highest perfection which the progress of scientific microscope construction has rendered possible.

IN the January number of *Science Progress* Dr. F. A. Mason gives a second instalment of his article on the influence of research on the development of the coal-tar dye industry. This deals first with the synthesis of substantive dyes, and then with the technical production of indigo, the new vat dyes, and the sulphur colours. A very interesting account is given of the indigo problem. "In 1880 a step was taken which could only have happened in Germany, and where the boards of directors were composed largely of able and far-seeing chemists: the two great firms of the Badische Company at Ludwigshafen and Meister, Lucius, und Brüning at Hoechst joined forces in order to attack the problem systematically, and entered into an agreement to carry on researches conjointly, sharing profits and results." It was only after nearly twenty years that the problem was solved, and then the solution came as the result of an accident; it is now well known that the commercial success of the manufacture of indigo had its origin in the accidental breaking of a thermometer in the naphthalene undergoing oxidation to phthalic acid by strong sulphuric acid. The presence of a trace of mercury acting as a catalyst, and so enormously improving the yield of phthalic acid, made possible the artificial productions of indigo at a remunerative price, and led to the gradual extinction of the native industry, which formerly was valued at four or five millions sterling. The interesting later competition between the naphthalene process and the phenylglycine process is dealt with, as well as the connection between this industry and the development of processes of making liquid chlorine, hydrogen, and synthetic nitrates, which have played so important a part in the present war.

WHETHER the differences in the choice of food exhibited by the crossbill in Ireland are to be attributed to tastes formed by these immigrants in separate centres of dispersal is discussed by Mr. C. B. Moffat in the *Irish Naturalist* for January. The birds which effected a settlement after the invasion of 1888 showed a decided preference for the cones of the larch, while those which formed part of the invasion of 1909 chose rather the cones of the Scotch fir. Observations made during the summer of 1915 showed that while larch cones were abundant they were comparatively neglected in favour of the Scotch fir. The author also casts doubt on the generally accepted belief that the cones of the Spruce fir form the staple food of the common crossbill, in the Continental parts of its range, those of the Scotch fir being exclusively eaten by the larger parrot crossbill.

FROM the annual report of the Department of Agriculture, Nyasaland, we learn that the extension of tea-growing in the Mlanje district is very satisfactory and that good prices have been realised. Cotton is still the most extensive cultivation in the Protectorate, but the commercial cultivation of Egyptian cotton has now ceased after exhaustive trials, the type compared with Nyasaland Upland proving unprofitable, probably owing to its sensitiveness to climatic variations and to its susceptibility to bacterial blight. The total acreage under cultivation in the Protectorate is a good deal less than that reported in the previous year, largely due to the abandonment of Ceara rubber and to the sad loss of several of the younger planters in the defence of Karonga. Afforestation at Zomba and Mlanje with the native Mlanje cypress (*Widringtonia Whytei*) is being continued, and the extensive Eucalyptus plantations near Zomba and Blantyre have made remarkable growth. This tree is undoubtedly destined to be the fuel tree of Nyasaland.

A GREAT deal of useful information about Egypt is contained in the Egyptian Government Almanac for 1916 (Cairo: Government Press), a small paper-covered volume costing one shilling. It is, in fact, an epitome of the geography, commerce, industries, Government and public services of the country. There is even a list of the Government publications, the only omission in which is a summary of the maps published by the survey department. There is, however, a short article dealing with the work of the survey.

A MAP of South and Central Africa on a scale of 1 to 5,000,000 has just been published by Bartholomew. The coast from Dar-es-Salaam to Mombasa is shown in an inset on an enlarged scale, as are also the principal ports. We notice that South-West Africa is outlined in red, and the colouring of German East Africa and the Cameroons may be considered transitional, as the brown colour appears only as a border. The map is finely executed and clear, and should be useful in following the forthcoming operations against the Germans in East Africa. There are one or two corrections in the railways needed. Upington and Warmbad are now linked by rail—an important factor in General Botha's subjugation of South-West Africa. The map is sold at half a crown.

IN the course of a lecture on the romance of the Indian Surveys (Journal of the Royal Society of Arts, January 21) Sir Thomas H. Holdich commented on the policy that the Indian Government had shown with regard to frontier exploration since the war with Afghanistan. Up to that time a good deal had been done by individual effort, which was then discouraged, if not forbidden, by Government. While the discountenance of irresponsible travellers may be necessary in the interests of the peace and security of the frontier, it is a policy that cuts two ways. Undoubtedly it has curtailed the possibilities of seizing on favourable opportunities for securing geographical knowledge. For half a century we learnt nothing of the wild border hills fringing the great plateau of Afghanistan and Baluchistan, or of further Kashmir, or the great Tibetan tableland, all of which, from a military point of view, it was essential we should know. Sir Thomas Holdich contrasted this policy with that pursued by Russia during the same period, or that which would most certainly have been pursued by Germany had she been in our place, and he doubts whether the excessive caution of our Government was not misplaced.

THE State Geological Survey of Connecticut, U.S.A., has published a useful illustrated summary of the fossils of the well-known Triassic formation of the Connecticut Valley, by Prof. R. S. Lull, of Yale University. It is now generally agreed that the rocks themselves are deposits formed on continental land, either in lakes or streams, or accumulated by winds, and their chief interest consists in the large areas covered with the well-preserved footprints of reptiles and other animals. Prof. Lull devotes attention chiefly to the footprints and to a discussion of the few reptiles already known from the same formation which may have made some of them. The large majority of the footprints are evidently those of dinosaurs, but a few are more satisfactorily ascribed to primitive crocodilians.

WE have received from the Peabody Museum of Yale University reprints of four papers by Prof. R. S. Lull on the distribution of dinosaurian and mammalian remains in the Cretaceous formations of Wyoming, and on the skeleton of a Pleistocene ground sloth, *Mylodon harlani*, from Rock Creek, Texas. With the Mylodon were found a nearly complete skeleton of the extinct horse, *Equus scotti*, and remains of a new species of horse, which are described in another paper by Mr. E. L. Troxell. The Cretaceous and Tertiary remains of birds in the Marsh collection in the Peabody Museum are catalogued and described by Dr. R. W. Shufeldt in a paper reprinted from the Transactions of the Connecticut Academy (February, 1915). The fossil cycads in the same collection are still being studied by Dr. G. R. Wieland, with valuable results; and the Palæozoic fossils are dealt with by the director of the Palæontological Laboratory, Prof. Charles Schuchert, who is to be congratulated on the activity which the Yale school continues to display.

THE unusual size of the science reports of the Tôhoku Imperial University, Sendai, Japan, is partly atoned for by the beauty of their photographic illustrations. In No. 1 of vol. iii. (1915), Hikoshichirô Matsumoto describes "Some fossil mammals from Sze-chuan, China," and introduces us for the first time to the contemporaries of Stegodon in China. This Late Pliocene fauna resembles that of India and Java, a new genus, Proboselaphus, representing the Boselaphus of the latter. H. Yabe contributes three papers to No. 1, vol. v (1915), the first of which, written in English, should be read in connection with Suess's conclusions as to the tectonics of south-western Japan. The third paper, in German, discusses the genus Halysites. The author, in the classification of the forms of this problematic coral, lays stress on the absence, presence, and stage of development of connecting tubes between the corallites, and illustrates this point in photomicrographs of cross-sections of the species.

THE February issue of the Monthly Meteorological Charts of the North Atlantic and Mediterranean, issued by the authority of the Meteorological Committee, includes an instructive graphic summary of the results of the exploration of the atmosphere and of highest flights of kites, aeroplanes, and balloons. It shows that the greatest height reached by a *ballon sonde* was some 22 miles, where an absolute temperature of 221° was recorded. The average height reached by *ballons sondes* is about 10 miles. The highest ascent of a manned balloon was made in Berlin in 1901, when a height of more than 10 kilometres was reached, and a temperature of 231° absolute was registered. It is noted on the diagram that above 10 kilometres no clouds occur, and that from this height to about 37 kilometres the temperature is almost the same. Above a height of two kilometres the temperature is, on the average, below the freezing point of water. Above a height of nine kilometres mercury freezes, and at about seven kilometres the average temperature is equal to the lowest ever recorded in the British Isles. The illustration shows also the heights of certain mountains and the temperatures recorded at their summits, and the general levels at which the chief types of cloud occur.

IN the annual number of the Journal of the Scottish Meteorological Society Dr. A. Crichton Mitchell gives a summary of some important investigations carried out by Dr. G. W. Walker, the head of the Indian Meteorological Department. In his search for trustworthy factors upon which might be based a possible forecast of the Indian monsoon rains, Dr. Walker has subjected the suggestions of various authorities to critical statistical analysis. He finds that a definite relationship involving a variation in the opposite direction exists between the Indian monsoon rainfall and the snow accumulation on the Himalayas, the pressure at Mauritius, and the rainfall at Zanzibar respectively. Further, a distinct relationship involving a variation in the same direction exists between the Indian monsoon rainfall and the pressure in the Argentine, and a less definite relationship of the same kind between the monsoon rains and the previous year's pressure in India. Dr. Walker shows how the various factors may be combined in an equation from which the variation from normal of the monsoon rainfall may be calculated, but the results so far obtained, while distinctly encouraging, point to the existence either of errors in the available data or of factors yet unknown. An interesting point is the demonstrated absence of any definite relationship between the Indian monsoon rainfall and the Indian temperature in May of the same year. If, as is generally held, the Indian monsoon is largely caused by the prevailing high temperature over the low grounds of India itself, one would expect that a year of high temperature would be also a year of high monsoon rainfall. Dr. Walker suggests that the absence of any relationship of the kind may be due to our ignorance of the effect of solar radiation upon the upper layers of the atmosphere, and that a high rainfall may possibly be connected with excessive heating of the upper rather than of the lower air.

THE opening of the Upper Jhelum Canal in the Punjab on December 9 last marks the concluding stage of a series of engineering operations which have extended over a period of ten years, and involved an expenditure of nearly 3,000,000*l*. It is the last instalment of the triple canal scheme, which, in its turn, forms part of the system of seven great perennial canals distributing the flow of the Jhelum, Chenab, Ravi, and Sutlej Rivers in an equable and scientific manner over 17,000 square miles of country, otherwise, and formerly, only suitable for the raising of camels and beasts of pasture, but now adapted to agricultural development. The irrigation area of the seven canals already exceeds 4½ million acres, 1½ millions of which are devoted to wheat and ¾ million to cotton. When fully developed, the triple canal scheme will add another 1¾ millions acres to the total. The necessity for the perennial canal system arises from the fact that in the Punjab there are two distinct agricultural seasons and two annual crops, both essential to the successful financial working of the land. During the first of the seasons, that is, in the six hot months (April to September) the ground is plentifully supplied with moisture from the melting snows of the Himalayas, in conjunction with the ordinary rainfall. In the second six months, the cold period, the rainfall is at a minimum and the rivers carry but low supplies. The conservation and uniform distribution of the water is, accordingly, a matter of extreme importance. The introduction of the canals has been attended by very satisfactory results, and the complete realisation of the project will, it is hoped, prove, from an economical and administrative point of view, a success of considerable magnitude.

"When the accelerations of three points of a rigid body are given, the acceleration of any point is known." This statement has been partly verified by Burmeister and others. In the Bulletin of the American Mathematical Society (vol. xxii., 3) Prof. Peter Field shows that the problem can be solved very simply by using the expressions for the accelerations which are ordinarily given in text-books on mechanics, and by this method the kinematical meaning of the solution is also evident.

The attempts to obtain a hydrodynamical solution of the problem of eddy formation in the wake of a moving solid have hitherto met with only very partial success. A solution was attempted by Von Kármán for motion in two dimensions on the hypothesis that a steady motion exists in which the vortices retain the same arrangement relative to the body. In a paper in the Proceedings of the Royal Society of Edinburgh (vol. xxxv., 1, No. 9) Mr. H. Levy has now shown that such a distribution can never be stable. Unfortunately, the pressure equation, which the author describes as "a necessary condition in any hydrodynamical problem," is incorrect except in cases of steady motion, of which the present is not necessarily one, and the results therefore appear to require further confirmation.

The problem of the personal equation is always interesting, but somewhat elusive of direct estimation in complex operations. In the *Psychological Review* (vol. xxiii., No. 1) J. H. Harris records the results of some experiments which he has conducted for some time on subjects engaged in estimating moderately large samples of bean seeds, either for germination tests or for determining the mean weights for different seeds. The advantage of the method lay in the fact that the subject could compare his estimate with the true value, and so attempt to profit by his experience. As a result of many observations and careful computations, he finds that the personal equation is remarkably little affected by experience, while, on the contrary, steadiness of judgment is unmistakably influenced by previous experience.

Part 1 of vol. xii. of the Bulletin of the Bureau of Standards contains an account of an examination of twenty radiation pyrometers by Messrs. G. K. Burgess and P. D. Foote, of the bureau. All the ordinary types of instrument were tested, and from the results obtained a number of general conclusions are drawn. In general, radiation pyrometers behave not as perfectly black, but as grey bodies, and the law connecting the indication of the instrument with the temperature of the source deviates from the fourth power by plus or minus 0·5. The principal errors of the instruments examined were due to faulty design and construction, but dirty or oxidised mirrors may produce errors of the order of 100° at 600° C. Smaller errors may arise owing to stray reflections, convection currents, and wrong focusing. The types of black-body furnaces in use at the bureau are described, and some account is given of the use of the pyrometers for the estimation of the temperatures of non-black bodies.

We have received a reprint of an interesting article on telegraphic transmission, contributed by Major W. A. J. O'Meara to the *Royal Engineers' Journal*. He points out that during the past seventy years or so, although great improvements have been made, the source of energy almost universally employed for transmitting the signalling wave impulses is at constant potential so that square-topped waves are sent. The sine wave, he is convinced, would be preferable. He supports the views to this effect recently expressed by Lieut.-Col. Squier in a paper before the Physical Society. The sine wave is the only one which can pass through the cable without changing its characteristic form, and the harmonics required to build up the impressed square-topped wave are absorbed in the cable, and merely represent a surplus charge for each signal, which must be got rid of before the succeeding signal can be sent. Lieut.-Col. Squier's proposal is to utilise an uninterrupted alternating current of pure sine wave form, and to alter the impedance of the transmitting circuit at the zero point of the wave. This will alter the amplitude, and by making each semi-wave of either sign represent an elemental signal, but giving the dot twice the amplitude of the space semi-wave, and the dash twice the amplitude of the dot, the Morse alphabet can be sent with the maximum rapidity and efficiency.

Referring last week (p. 633) to Messrs. Isenthal and Co.'s new list of rheostats, we expressed the hope that they would continue to manufacture the resistances in England after the war. Messrs. Isenthal believe that even if after the war the present strong feeling against German-made goods should somewhat subside, a great many of their clients will always prefer to buy the British-made article. Moreover, having invested a not inconsiderable sum in the necessary machinery, press tools, and jigs required for the manufacture of the rheostats, they hope to retain and extend the markets opened to them by the temporary paralysis of German export trade. Messrs. Isenthal also inform us that they find "by careful organisation, by manufacturing the component parts of these rheostats in very large quantities, *i.e.* practically making the whole rheostat except the winding in very large quantities," the instruments do lend themselves to mass production. Before the war they did not consider themselves justified in incurring the expense and work required for such methods of manufacture, and therefore purchased the apparatus from abroad. But they add:—"The closing of our relations with the central Continent has given just that impetus which was needed for us to set aside *ordinary* commercial considerations, hence our present facilities for manufacturing this apparatus."

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES.—Mars, now nearly as bright as Sirius, will be in opposition early on Friday. Jupiter and Venus, so conspicuous in the western twilight, reach conjunction about 3 a.m. on February 14. Their nearest approach takes place earlier, about midnight, Venus being 26′ S. Even at 7.30 p.m., February 13, they will be only 32′ apart. The moon occults a 3·2 mag. star, ε Geminorum, on February 14. As seen from Greenwich disappearance occurs at 11h. 3m. The moon is in conjunction with Neptune on the evening of February 16 at 6h. 24m. Geocentrically the planet will be 1° 2′ S. Comet 1915*e* (Taylor) can still be glimpsed with a 3-in., but is not a suitable object for such a small aperture. The following positions are from a continuation of the Copenhagen ephemeris for Greenwich midnight:—

		h. m. s.		° ′
Feb. 11	...	5 30 22	...	+24 21·3
15	...	36 45	...	25 39·0
19	...	43 48	...	26 50·8

SHIFTS OF WAVE-LENGTHS.—Modern measurement of wave-lengths, in striving successfully after an accurate third decimal figure, has begun to detect all kinds of causes that result in wave-length alterations. In solar spectroscopy, in addition to the well-known pressure and motion effects, the recondite theory of relativity and the ubiquitous anomalous dispersion championed by Freundlich and Julius respectively have afforded explanations of the observed displacements. In the one case it is an intense gravitational field that is adduced as competent; in the other the mutual effect of neighbouring lines. In the laboratory length of arc, its internal pressure, distance from pole, impurities, change of electrical conditions, have been described as the source of displacement by Royds, Albrecht, St. John, Burns, and Bilham. The latter, working in Prof. Fowler's laboratory at South Kensington, has now studied the special case where the adventitious element itself gives rise to strong lines (*Astrophysical Journal,* December, 1915). A number of iron lines in the regions of H and K were measured in the spectrum given by a carbon arc fed with Fe filings, and also when the arc was fed with a mixture of filings and calcium chloride, the calcium lines being measured in both cases. The results obtained in this very interesting research indicate that some lines are susceptible, whilst others have constant wave-lengths. The K line of calcium is found to differ by 0·008 Å. in the two sources. One hesitates to think of the array of conditions it will become necessary to introduce into the specification of standard lines.

FURNACE SPECTRA OF COBALT AND NICKEL.—To the metals (Fe, Ti, V, and Cr) whereof the electric furnace spectra have already been investigated in such painstaking and accurate manner by Dr. King, must now be added Co and Ni (*Astrophysical Journal,* vol. xlii., No 4). Fourteen pages are given up to tabular matter similar to that for the elements previously studied. Attention may be directed to some results of an unexpected character; thus not only is the violet end found relatively rich in lines, but all the enhanced lines of cobalt (except only λλ 3878·90 and 3904·23) in the region of shorter wave-lengths than λ 4077·56 have been classified as furnace lines. Another peculiarity is the fact that each of the classes I., II., and III. contain some lines that attain a maximum in the furnace and are weaker in the arc, thus affording, as regards the lines of Class III. A, a group of lines special, perhaps, to a range of temperature of some 500° C.—a feature worthy of further attention.

THE ELECTRO-THERMIC SMELTING OF IRON ORES.

THE rapid growth of the application of the electric furnace to the metallurgy of iron and steel is certainly the most noteworthy feature of the development of this industry during the last decade. Ten years ago "electric steel" was largely a novelty. To-day there is scarcely a branch of this highly diversified and complex industry in which electrothermic heating has failed to secure a footing and to justify itself. This progress is all the more remarkable when it is remembered that the steel manufacturing industry "owing to its age and importance, and also to the capital invested in it, is one of the most conservative and settled of all industries."[1]

The earliest uses to which electric furnaces were applied were to the production of (1) ferro-alloys, containing iron, carbon, and such elements as tungsten, molybdenum, vanadium, etc., which indeed cannot be made in fuel-fired furnaces; and (2) of the highest classes of carbon and alloy tool steels, where they competed successfully with crucible furnace products. Having "made good" up to this point, they were next developed, not in direct competition with Bessemer and open-hearth furnaces, but as important adjuncts to them, and within the last seven years a great variety of products—*e.g.,* gun, tyre, and axle steel, wire and plate billets, and rail and girder steel—are manufactured with their aid. Such processes may be classed as electrothermic refining, for they take the metal as delivered by the Bessemer or open-hearth furnace, and, owing to their high temperature and more neutral atmosphere, permit the formation of refractory basic and even reducing slags, *e.g.,* calcium carbide, which carry the refining of the steel to a further stage, and produce a purer and more trustworthy metal. Especially has this been the case with the manufacture of rail steel in Germany and America, where it has been found that the trustworthiness of the steel is so much increased by electrothermic refining that the railway companies are willing to pay considerably more for rails produced in this way. Mention must also be made of the application of the electric furnace to the production of mild steel castings—always a difficult operation—where a very fluid metal can be obtained, and a better separation of gaseous and other impurities. Heroult[2] recently quoted instances in which it had been found to be unnecessary to anneal such materials at all, since their properties were fully as good as those of the best rolled mild steel made in

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[1] "Electrothermal Methods of Iron and Steel Production." By J. B. C. Kershaw, p. 3.

[2] Transactions of the Eighth International Congress of Applied Chemistry. New York. September, 1912.